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The student's perspective on school mathematics – a case study

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This paper is based on a long-term case study of students' experiences of reform mathematics classrooms in Finland. Specifically, it focuses on emerging school mathematical actions and activities experienced by three committed and engaged students. Students described their experiences in interviews during and ten years after lower secondary school. The paper asks why taking part in certain practices makes some students learn to like and others to dislike school mathematics, despite high attainment concerning reform-related objectives on achievement and responsibility. The case study showed the importance of making classrooms places where all students belong to communities in which mathematical knowledge is negotiated.

Keywords: Habits of the mathematics classroom, long-term case study, spaces for participation, student perspective.

Introduction

In mathematics education, it is challenging to develop classroom cultures in which students maintain positive relationships towards mathematics after their first school years (Sullivan, Tobias, & McDonough, 2006). Although Finnish students have performed well in mathematics in international comparisons, especially in the Programme for International Student Assessment (PISA), many Finnish students' attitudes, self-confidence and engagement are poor in comparison to other countries. Based on PISA 2003, Viking Brunell (2007) found that only one third of the students in Swedish-speaking classrooms in Finland looked forward to mathematics lessons, and one half did not express any interest in mathematics whatsoever. Later, the 2015 Trends in International Mathematics and Science Study showed that Grade 4 Finnish students had a less positive attitude towards school mathematics than those in other European countries (Mullis, Martin, Foy, & Hooper, 2016). This was especially the case with girls, who chose to invest in subjects other than mathematics quite early on (Metsämuuronen, 2017). While much research has confirmed some students' negative relationship with mathematics (cf. Brunell, 2007; Lewis, 2016), very few studies have focused on why engaged and committed students develop negative attitudes and abandon mathematics by neglecting to study advanced courses in the subject at upper secondary level. The aim of this paper was to contribute to our understanding of the reasons behind these choices.

For some decades, attempts have been made in many countries to improve/reform school mathematics to make it more meaningful for all students (Fennema & Scott Nelson, 1997). This has also been the case in Finland. This paper was situated in a reform context in a Swedish-speaking lower secondary school in Finland. The reform emerged in connection with a three-year action research project that focused on learning processes and assessment, especially those involving problem-solving and investigative project work. The national core curriculum declared that solving problems and attending to the internal logic of mathematics were the two most important principles

for mathematics teaching (Finnish National Board of Education, 1994). By probing and assessing the mathematical thinking of students, teachers wanted to encourage the discovery of useful and viable mathematical ideas that they described as ‘active’ knowledge and to support individual students’ emerging sense of control over and responsibility for learning to a greater degree than was possible through ‘ordinary’ classroom practices.

Few studies have investigated school mathematics from students’ perspectives, and we have not come across any studies that involved students as legitimate participants in an interpretive research methodology that relates to teachers’ reform work during lower secondary school and beyond. In the doctoral study on which this paper was based (Røj-Lindberg, 2017), participating students were interviewed several times from the age of 13 to approximately 25. In this paper, we aimed to answer the following question, “Why do some committed and engaged students develop a negative identity concerning mathematics during lower secondary school?”

School mathematics from the student’s perspective

About thirty years ago, Alan Schoenfeld (1988) argued that school mathematics might unintentionally produce “disasters” even though most actions and activities in mathematics classrooms proceed as envisaged by teachers in terms of the curriculum and teaching practices. As a result of his inquiry, Schoenfeld called for broad research agendas that should aim “to understand the world from the student’s point of view” (p. 165). His message was that if learning could be perceived as much more than what can be inferred from observing students in classrooms, including their mathematical performance, different forms of assessments, and so on, then the voices of students really should start to matter in school mathematics and educational research. Since then, the same type of request has been formulated repeatedly both outside and within mathematics education (Berinderjeet, Anthony, Ohtani, & Clarke, 2013).

Jo Boaler (2003) defined classroom practices as the recurrent activities and norms that develop in classrooms over time. We argue here that even if researchers are strongly focused on changing classroom practices, they have tended to apply a top-down perspective, looking at students and processes of learning from the outside. Classroom practices have been studied in isolation from students themselves, though they have been conceptualized as methods of teaching¹ that provide a social context that influences and allows the experiences and expectations of students. From an observer’s perspective in a classroom, it may be possible to describe and conceptualize regularities within observable actions and activities. But such a stance does not take into account the notion that activities and actions in the classroom are complex when seen from the perspectives of students who are the immediate participants.

Here, we have taken reflexivity as a premise of the research and argue that students’ accounts of what happens or is expected to happen in mathematics classrooms are socio-cultural in their very nature. We have accepted that social situatedness should be taken as a premise when students’

¹ In the literature, teaching methods have been described in different ways, for instance, as open, progressive, traditional, constructivist and discussion oriented.

perspectives are the focus of interest. Whatever else might be innate, students' expectations concerning school mathematics are not; these are formed over the years, largely through students' interactions with their parents, peer group and teachers. Based on such a premise, we interpreted the experiential accounts given by students in interviews as having a social and cultural origin. Interpretations can be created through "zooming in" (Lerman, 1998) on the complex territory of classroom practices through accounts given by students and by looking at classroom actions and activities through students' 'eyes'. On the other hand, one must "zoom out" to view individual students' experiential accounts without losing contact with the actions and activities that constitute school mathematics in their individual classrooms.

The study was embedded in social practice theory and focused specifically on students' alignment and their development of identities and imagination in relation to classroom practices in which they took part. Learning was defined as increasing participation in classroom practices, which were understood as social processes where meanings are negotiated and students become or avoid becoming persons for whom mathematics is important (Wenger, 1998).

Methodology

This paper was based on a case study (Røj-Lindberg, 2017) within the context of teacher-initiated action research and reform work. The main case record material (see Bassey, 1999) was semi-structured interviews with four to five students from each reform classroom, in total 120 interviews with 27 students. Four to five interviews were done with each of them during the three lower secondary school years. Students were asked to describe and comment on their experiences of school mathematics, including their wishes and expectations, for instance, in relation to recent mathematics lessons. Students were also probed about their views on problem-solving activities and other reform-related activities, for instance, on being asked to explain one's thinking publicly. Interviews with three committed and engaged classmates, Joakim (male), Kristina and Nette (females), were selected for further analysis for the case study. These three students, who had experienced the same classroom context, were also invited to look back on their experiences as adults. Adult interviews were conducted when the three students had finished university and focused not only on lower secondary school classroom practices but also on mathematical practices more widely. The first author's preliminary interpretations of the lower secondary school interviews were used as inputs in the adult interviews, which were conducted to deepen the researcher's understanding of school mathematics from a student's point of view, not for fact-finding.

The analysis of the interviews, which were conducted in Swedish, was first inductive and then deepened through holistic interpretations of each interview (see Merriam & Tisdell, 2016). The researcher's responsiveness to emic issues appearing in students' accounts was high. Important emic issues were *structure and closure* emerging from the lower secondary school interviews and experiences of *identity work* from the adult interviews (see Røj-Lindberg, 2011, 2015). Emic issues were theoretically connected to Wenger's social practice theories. In the final analysis, they were connected to other theoretical constructs from this theory, such as communities of practice (applied to school mathematics), negotiation of meaning, modes of belonging and students' trajectories within a specific practice. These were applied during the interpretation of interview accounts. It is

beyond the scope of this paper to give a thorough explanation of the use of these constructs. It is also impossible to give an exhaustive account of the extent to which the reform influenced activities in the classrooms (for detailed information, see Røj-Lindberg, 2017). Yet, when presenting the results we connected the issues brought forth by students to relevant classroom events. The quotes have been translated into English by the first author. Results presented here do not intend to generalise but to understand school mathematics as it emerged in one reform classroom from students' perspectives.

Results

In the following section, we have introduced the students, Joakim, Kristina and Nette, and their trajectories (Wenger, 1998) in mathematical practices. Next, we have reported two reasons that we claim to be of crucial importance to students who make negative choices concerning the role of mathematics in their lives. These reasons are neither mutually exclusive nor exhaustive. They are more like what can be seen in a kaleidoscope; each turn gives a new view of school mathematics from the student's perspective.

Student trajectories

As newcomers in the seventh grade, Joakim, Kristina and Nette were highly engaged students. Nette's engagement clearly related to an imagined future as a veterinarian, while Joakim and Kristina were generally confident about the significance of learning mathematics. During lower secondary school, they were responsible students who were evaluated by the teacher as skilful/capable in different types of assessment. They wanted to take part in actions and activities in school mathematics communities, and they appreciated the problem-solving activities that were introduced within the reform. In short, we can describe them as successful students who expressed strong alignments in relation to reform objectives. Nevertheless, their trajectories and identifications related to school mathematics were constituted very differently over the following school years, which strongly affected their futures. Joakim's trajectory continued to be structured by positive choices concerning mathematics. He passed the advanced mathematics courses he had selected in upper secondary school² with success and chose a mathematics-intensive university program to obtain a MSc in engineering. The trajectories of Kristina and Nette differed significantly from Joakim's. Both of them chose basic mathematics courses at secondary level and neither of them chose university programs that included mathematics. Nette's dream of becoming a veterinarian turned into a claim that mathematics was not for her, and she chose a university program in psychology. Kristina described school mathematics as a more or less alienating experience, but in contrast to Nette, she continued to be very accepting. However, she dropped her plan of studying science, because she did not want to align with the workings of the mathematics classrooms she had experienced in school. Instead, she chose a university program in pedagogy.

² The upper secondary mathematics curriculum is divided into basic and advanced level courses. Only students who select advanced courses must take mathematics in the matriculation examination.

The dominant habits of the mathematics classroom

From a student perspective, the actions and activities in a mathematics classroom are complex. A characteristic that supports participation in the case of a student at one moment in time might not be supportive for all students and might not continue to be supportive for that student over time. However, our analysis of students' interview accounts showed recurrent patterns in mathematics classrooms that we described as dominant habits. As the space of the paper does not allow us to thoroughly account for all habits, we have chosen those that most likely led to the development of non-participation (Wenger, 1998) of Kristina and Nette in the long run. Two dominant habits that appeared in all student interviews in the case study were as follows:

(1) The "all-look-alike" structure of lessons, which contributed to the sense that mathematics was a monotonous subject and led to a kind of meaninglessness for students who did not accept non-participation as an adventure (see the work of imagination, Wenger, 1998, pp. 185–186):

All lessons look alike, we have theory and write down the things we are doing. The teacher asks different things. Then, we may count at our own pace from the book. The last lesson we did x times x and such. (Nette, Grade 7)

I don't think there have been any changes. It just continues from year seven to year eight and then, to year nine. In my opinion, nothing has changed. It has been fairly similar all the time. Of course, they follow and teach by the book. (Nette, Grade 9)

(2) The general mode of working individually during lessons, which meant that students were mostly left by themselves to struggle for coherence regarding mathematical structures. Hence, there were limited opportunities to develop a sense of belonging to any community where mathematical knowledge was negotiated in the classroom:

We do work alone all of us. It is like that anyhow, the teacher has to come to everybody, so it is the fastest way to ask the one you sit next to, so you talk to everybody. (Kristina, Grade 9)

Joakim continued to take part in communities that included the teacher and students he described as "smart". Moreover, the support he received from his teacher reminded him repeatedly of his membership in communities of mathematically-able people.

The textbook continued to be the main pedagogical artefact during the reform, and teachers continued to structure the tempo of student learning with the textbook. The habit of working alone with textbook tasks may have added to some students' sense of enjoyment. But as Kristina stated, the positive effect emerged only "when you succeed and keep up with new things". In the long run, both Kristina and Nette expressed a sense of not keeping up with the tempo. Hence, the way the textbook was used in the classroom may have contributed to their developing identities of non-participation.

All students who took part in the case study welcomed reform-related activities, such as investigative project work, which "did show a little what mathematics can be", as Joakim stated as an adult. However, some students considered investigative project work to have a marginal role in their learning of mathematics even if their accounts clearly described the opposite:

You learn things that don't have so much to do with mathematics. I did learn about unemployment rates in Finland. But this has nothing to do with mathematics. I think that I haven't learned anything that has to do with mathematics. I mean, like what we are doing in the book for (math) theory. I don't learn in that way when I do investigative work. (Kristina, Grade 9)

In general, reform-related activities had the potential to increase participation for all students. Yet, as the extract above shows, students did not always see the connection between these activities and their development of mathematical knowledge. Therefore, the activities did not necessarily enhance students' participation.

The character of spaces for participation in classroom practices

We defined learning as increasing participation in classroom practices. Thus, it is natural to consider the character of mathematical spaces where meanings were negotiated in the classroom (Wenger, 1998). We have attended here to the most obvious characteristics that seem to have contributed to some students becoming persons for whom mathematics was not important.

The most important aspect was that "right or wrong" classroom practices limited the possibilities for constructing mathematical knowledge for all students. Nette succinctly captured this aspect and her perspective on one of its side effects, which was that questioning might be interpreted by the teacher as a lack of responsibility for learning and not as comments from students striving for understanding:

You cannot dispute lower secondary school mathematics, because it is right-or-wrong mathematics. If you start questioning it, the teacher thinks you are trying to escape. (Nette, adult)

Within "right-or-wrong" practices, there was little room for social, playful and investigative mathematics. Aligning to the practice meant individually struggling for coherence and understanding by listening to the teacher. The struggle for understanding was accompanied by feelings of insecurity, because the act of giving a wrong answer in public was shameful.

When students are supposed to answer in public, I get fairly nervous. I think what if I give the wrong answer. (Nette, Grade 7)

You have to listen all the time to what the teacher is saying and you get so tired. As soon as you talk just a little bit with your friend then it goes, oh, now I do not understand anything again. It is rather strenuous. You should have a better ability to concentrate. (Kristina, Grade 9)

Reaching the right answers rapidly was, from the students' perspective, a sign of understanding and often meant immediate rewards, such as praise from the teacher or not being constrained by homework. The case study showed that tentativeness, wrong answers, misinterpretations or extended interpretations of textbook tasks were not considered by students to be characteristics of a space where every student could belong and participate. For some students such as Nette and Kristina, this situation contributed to the development of negative identifications towards mathematics, which strongly affected their futures.

Discussion

We argue that a main concern for reforms in mathematics education should be a critical focus on the reality of the classroom, which from students' perspectives is even more complex than interviews can reveal (see Berinderjeet et al., 2013). Also, dimensions that extend the classroom level had an impact on students' relationship to mathematics. According to Gregg (1995), reformers should encourage teachers to think in new ways by implementing new 'idioms' into their stories and explanations. This is, however, exactly what teachers who were involved in this case study did; they were supported by the scholarly community to integrate new idioms based on constructivism (see, for example, Black & Atkins, 1996) into their talk about classroom practices. Idioms such as active learning, discovery processes and responsibility for knowledge construction were strongly present when teachers talked about reforming their practice. Yet, they did not oppose the epistemological hegemony of academe by asking, "What if we lift our gaze from the student as a 'constructing individual' to zoom out and include the 'socio-cultural whole of the student and ourselves?'" They attended to the practice-in-individual but not to the individual-in-practice (Lerman, 1998). The latter perspective confronts us with the question "What is the nature of school mathematics practices in which all students should become qualified in order to develop positive identifications and to enhance the role of mathematics in their lives?" This question must be the starting point whenever we want new curriculum ideas to change classroom culture in a direction that makes participation an inclusive experience for as many students as possible. This is an issue to which hardly any research attends.

Several factors interacting in a complex manner influence students' choices and relationships to mathematics, and, therefore, it is valuable to explore some cases deeply to understand them. In this study, Wenger's (1998) theoretical constructs proved fruitful for revealing hidden regularities behind the development of students' negative identifications concerning mathematics. According to Wenger, learning is so much more than gaining skills and knowledge, it is a process of becoming that transforms both who the learner is and what the learner can do (p. 215). Concerning the results presented here, this is a very strong statement. When students, regardless of gender or school mathematical practices, learn disengagement (e.g., Sullivan, Tobias, & McDonough, 2006) or explicitly refuse mathematics in school (e.g., Chronaki & Kolloche, 2019), their lives as adults, and especially their possibilities to partake in the working life, might be diminished.

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